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A review of trends, policies and plans for increasing energy access in Ghana

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ABSTRACT

The need to secure future energy in the forms of electricity and modern cooking fuels is recognized as critical to achieving the Millennium Development Goals, particularly poverty reduction, ensuring improved education, health, water supply and environmental sustainability. This paper presents a review of the trends, policies, plans and programmes for increasing energy access in Ghana with primary focus on electricity, cooking fuels and renewable energy. The paper argues that even though governments over the years have had the provision of energy services high on the national development agenda, past and existing policies and plans have not delivered effective results to accelerate energy access, especially in the rural and peri-urban areas where the services are badly needed. The paper therefore calls for a coherent national energy policy with inputs from a wider section of the public that has precise targets and clearly laid down strategies, including financing mechanisms to achieve the targets.

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1. Introduction

The critical role played by energy in achieving sustainable development is well recognized and the disparity existing between urban and rural areas of African countries in terms of access to energy services was highlighted and widely agreed upon at the Johannesburg Summit in 2002 as a major concern by the United Nations and other world bodies [1,2]. In spite of the widespread consensus that, the provision of affordable, reliable, and socially acceptable energy services are prerequisites for achieving the Millennium Development Goals (MDGs) [3], inadequate access to energy services continues to be a major challenge to sustainable development.

The global energy sector faces a number of challenges including lack of access to the electric grid at reasonable prices, volatile oil price markets, high initial cost of renewable energy technologies, widespread lack of awareness of the scale of renewable energy resources, increased greenhouse gas emissions, etc. [2,4,5]. Although most of the challenges facing developing countries are similar to those in the industrialized countries [4], fragile economies, growing population, low investments and poor energy infrastructure, among others, compounds the challenges of developing countries.

Ghana's energy sector policy objectives of ensuring reliable, adequate and cost-effective supply of high quality energy services for households, industries, agriculture and transport are consistent with the outlined prerequisites for achieving the MDGs [6]. Ghana has also subscribed to the energy access targets of the 'Economic Community of West African States (ECOWAS) White Paper for a Regional Policy' geared towards Increasing Access to Energy Services. The ECOWAS White Paper which proposes to enable at least half the population of the West African sub-region have access to modern energy services by the year 2015 [7]. However, existing policies and plans have not delivered effective results to enable the population derive the maximum benefits of increased access to energy services. There is also a lack of data to determine whether current energy policies and plans will achieve the targets for energy access as set in the government's policy documents, ECOWAS White Paper and the MDGs. Policies and plans to provide the enabling environment for improvement in energy access are hardly evaluated and hence the need for a continuous research especially for monitoring and evaluation purposes. Nearly 50% of the Ghanaian population who do not have access to grid-electricity and about 90% who do not have access to liquefied petroleum gas (LPG) for cooking rely on firewood and charcoal [8,9]. Their hope is to improve their socio-economic well-being by gaining access to modern forms of energy.

Given the above context, this paper examines national policies and plans for promoting increased access to energy services in Ghana with particular focus on electricity, cooking fuels and renewable energy. The paper is organized into four sections: Section 2 reviews the trends in Ghana's energy sector within the context of household energy services. Section 3 discusses the various national energy policies, plans and programmes, the policy mechanisms and institutions and the key challenges. Section 4 addresses the key issues and options for Ghana's energy access. Section 5 makes conclusions and recommendations.

2. Trends in Ghana's energy sector

This section reviews trends in the energy sector of Ghana with particular emphasis on energy at the household level, namely, electricity, LPG, kerosene, and renewable energy including woodfuels (firewood and charcoal).

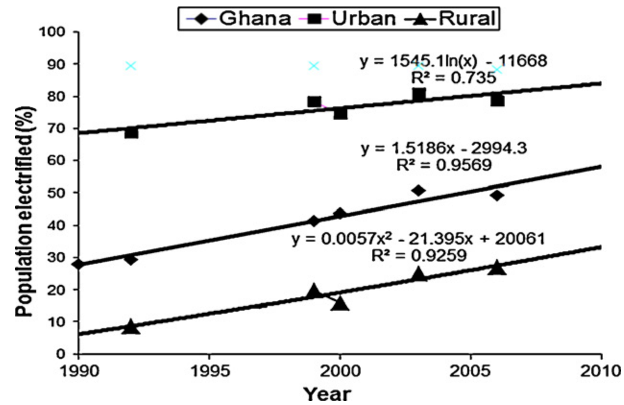


Fig. 1. Trends in electrification in Ghana.

Source: [12].

2.1. Electricity

The colonial administration of the then Gold Coast maintained a diesel generation station without any intention for a rigorous energy programme [10]. The Government of Ghana initiated the Volta River Project and established the Volta River Authority (VRA) in 1961 for the generation and transmission of power. Four hydroelectric generating units with total capacity of 588 MW, including 15% overload capacity, were installed in 1965 at Akosombo. Two additional units with capacity of 324 MW, including 15% overload capacity, were commissioned in 1972 to bring the total installed capacity of hydropower to 912 MW. In 1981, a second hydroelectric plant was installed at Kpong and this added 160 MW to the installed capacity [11].

In 1989–1990 government committed itself to increase access to electricity for all parts of the country over a 30-year period under the national electrification scheme (NES). The programme established projects that are targeted at the provision of electricity access to the northern parts of the country, which then had no grid power. In 1990, the VRA rehabilitated and re-commissioned the Tema Diesel Generating Station which has a capacity of providing supplementary generation of 30 MW thereby raising the total capacity of electrical power to about 1,102 MW.

Between 1990 and 2001, electricity consumption grew from 4457 GWh to 6033 GWh at an average rate of 9.42% per annum, excluding the Volta Aluminium Company (VALCO), whose aluminium smelter at Tema consumed around 40% of total electricity supply in the mid-1990s [6]. The increase in consumption, as compared with population growth of 2.67%, was due to an impressive increase in electricity access from 28% in 1988, 32% in 1992 and 43.7% in 2000 [6,12–14]. Electricity access rate of Ghana was estimated to be 54% in 2007 [12] and 55% in 2008 [15], making Ghana the third highest in sub-Saharan Africa, after Mauritius and South Africa. Fig. 1 demonstrates the trends in electrification in Ghana at the urban, rural and national level. Despite the increased access to electricity nation-wide, there exists a big disparity in access between the urban and rural areas as reported by the Ghana Statistical Service [13]. This dichotomy between rural and urban areas is revealed in a more poignant fashion in Fig. 2.

In 2006, Ghana experienced a power crisis due to low electricity generation capacity. The crisis spurred the government and VRA to review their long-term electricity policy in terms of the electricity generation mix required for national investments and long term needs [16,17]. Significant investments have since been made in thermal plants and system upgrading with the completion of VRA's 126 MW Thermal 1 Project. Several independent power projects are also at various stages of advancement, all at Tema. New hydroelectricity projects are being developed, including the construction of

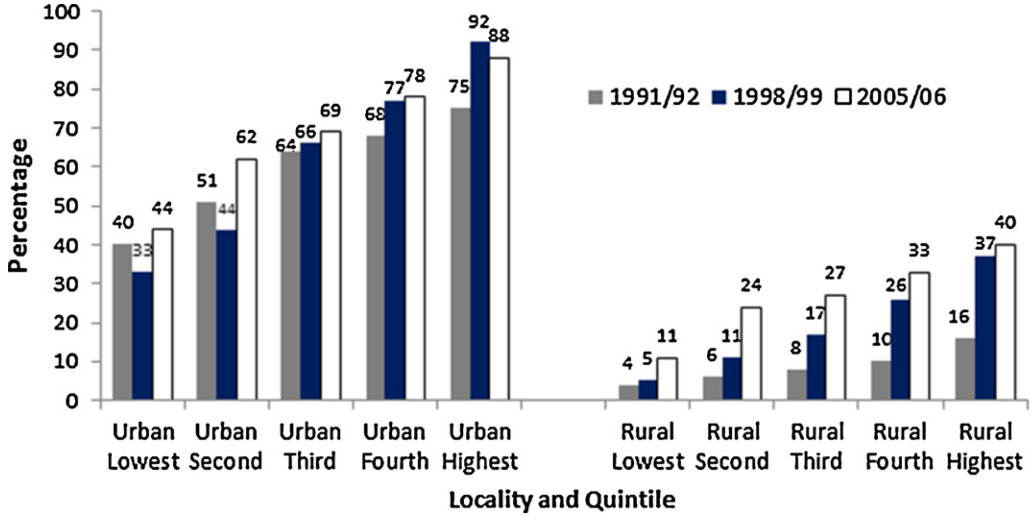


Fig. 2. Percentage of households using electricity by locality and standard of living quintile.

Source: [13].

the 400 MW Bui Power plant by the Chinese (Sino Hydro). There is likelihood of work starting soon on the Western rivers.

2.2. Liquefied petroleum gas (LPG)

In Ghana LPG is used as a fuel for cooking and transport. In 1990, the Government of Ghana launched a National LPG Programme under which the Tema Oil Refinery was to be modernized and a massive LPG campaign implemented. This offered the opportunity to promote LPG as an alternative energy to charcoal and firewood. The promotion targeted urban households, public institutions requiring mass catering facilities and the informal commercial sector including small-scale food sellers [5].

Government's initiative were fruitful since the consumption of LPG doubled in 1992, and by 2004 domestic consumption was over 60,000 tonnes/year which was estimated to be about ten times higher than the quantities consumed before the promotional programme was launched [9]. Though the LPG drive was successful, it is observed that patronage was skewed in favour of urban dwellers [9,18]. Denton [18] argues that given the high consumption of charcoal in urban areas, concentration in the urban areas is a positive step to reverse the rates of deforestation and thus reduce demand for charcoal and woodfuel.

Out of the 6% of households in 2004, and about 9% in 2005 using LPG as their primary source of fuel for cooking, 70% resided in Greater Accra and Ashanti regions. In Accra, the nation's capital, about 22.7% in 2004 and about 30.4% in 2005 of households used LPG [13,14]. Urban access to LPG was estimated to be 17.2% and in contrast, LPG in rural areas accounted for about 1.2% of total national consumption. A recent study found that only about 19% of households in the upper income quintile in Ghana have access to LPG, reducing to about 2% in the lowest income quintile group [19]. As of December 2003, there were 98 LPG filling stations in Ghana, 64 of which were situated in the Greater Accra region and only one station each in the Upper East and Upper West regions. In 2004, the Government with financial support from the United Nations Development Programme (UNDP) under its Rural LPG Challenge programme re-launched the LPG campaign programme to focus on the Northern regions of Ghana [18]. A national survey conducted by the authors in early 2011 indicates that there are currently more than 200 LPG filling stations in the country.

In the year 2007, the Tema Oil Refinery exported about 9616 tonnes of LPG and imported about 47,226 tonnes to meet local demand [20]. Fig. 3 demonstrates the quantity of LPG supplied to the internal market of Ghana from the year 2000 to 2007. Some authors have reported that one of the key constraints to the initial promotion of LPG was the relatively high upfront cost compared to that of woodfuel with the cost of the cylinder contributing significantly to the high cost [9,18].

2.3. Renewable energy sources

The African continent is endowed with abundant renewable energy resources [21,22] and Ghana is no exception. The country's renewable energy resources that have been extensively studied as potential sources for energy production and utilisation are bioenergy (particularly, solid biomass and biogas), solar, wind and small hydro.

2.3.1. Woodfuel (firewood and charcoal)

In 1985 it was estimated that about 10.7 million tonnes of wood was consumed in Ghana. Out of this, 2.1 million tonnes (20%) was for industrial and commercial use, while 8.6 million tonnes (80%) was used for charcoal and firewood. Charcoal production alone amounted to about 3.3 million tonnes of wood [23]. The estimated woodfuel consumption in million tonnes from 2000 to 2007 is shown in Table 1.

Ghana's energy commission [24] reports that firewood and charcoal contributed about 63% of the total energy supplied to the consumer compared to 27% for petroleum products, and 9% for electricity. A breakdown of the national energy balance data reveals that the residential sector of the country consumes the largest share of the energy supply due to the high reliance on woodfuel to meet

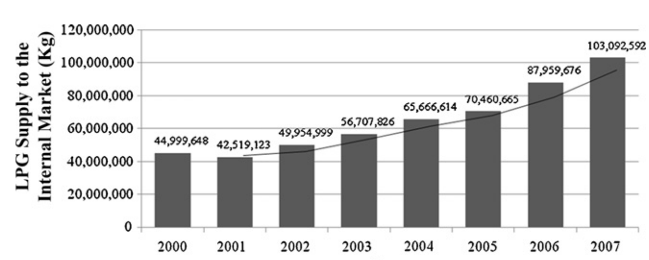


Fig. 3. LPG supply to the internal market (2000–2007).

Data source: [20].

Table 1
Estimated woodfuel consumption (in million tonnes), 2000–2007.

Estimated consumption (million tonnes)	2000	2001	2002	2003	2004	2005	2006[a]	2007
Wood used as firewood	7.1	8.0	8.3	8.6	8.7	8.8	–	9–10.8
Wood for charcoal production	5.0–7.5	5.2–7.8	5.4–8.1	5.6–8.4	5.8–8.5	5.8–8.5	–	2.1–2.3
Total primary woodfuel consumed	12.1–14.6	13.2–15.8	13.7–16.4	14.2–17	14.5–17.2	14.6–17.3	–	11.1–13.1

Source: [20].
[a] 2006 data not available.

Table 2
Percentage share of woodfuel consumption in Ghana (2000–2005).

Sector	2000	2001	2002	2003	2004	2005
Residential	72.3	71.8	71.3	70.8	71	71
Agriculture & fisheries	0.1	0.1	0.1	0.1	0.1	0.1
Industry	24.5	25.9	25.4	25.8	25.7	25.7
Commercial & services	3.1	3.2	3.2	3.2	3.2	3.2

Source: [27].

mostly domestic needs. Table 2 demonstrates the percentage share of woodfuel consumption in Ghana from the year 2000 to 2005. It has also been reported that the consumption of woodfuel increased by 58% between 2004 and 2008, while the consumption of charcoal also increased by about 50% during the same period [25].

In addition to firewood and charcoal, there are other biomass resources in the form of agricultural and forest wastes, animal wastes, saw-dusts, etc. The lack of comprehensive data and national programmes to indicate the actual total availability of biomass including agricultural, forest and wood processing wastes, particularly sawdust, goes back a long way [26]. This is due to the difficult task of monitoring and measuring the volume and weight of woodfuel harvested by families and individuals scattered over the entire country. Nonetheless, Energy commission [27] has recently indicated the following estimated potential reserves: wood for fuel (813–850 million tonnes), wood processing residue (1 million tonnes/year), and agricultural residues (1 million tonnes/year).

In order to reduce the consumption of woodfuels and to reduce in-door air pollution in cooking places, there have been some efforts towards disseminating improved cookstoves in the country. Among the prominent cookstoves that have been introduced in Ghana are the Ahibenso and the Gyapa. The Ahibenso stove, which could save about 18.4% on charcoal consumption compared to the traditional stove, was introduced in the early 1990s and some 40,000 stoves had been sold out by 1993. Current data on access and impacts are not available and the stove is not very popular in the country these days as compared to Gyapa. Gyapa stove was introduced in 2002 by Enterprise works and over 200,000 had been sold by 2006 through a vigorous marketing campaign [28]. The Gyapa stove has remained popular with Ghanaians and still continues to sell in various towns across the country. A wider dissemination of improved cookstoves is important in order to reduce woodfuel intensity in the country. In the end, the benefits of woodfuel use and avoidance of negative effects will most effectively be achieved by decentralised management approaches that build on local institutions and understandings of the resource [29].

2.3.2. Other forms of bioenergy

Interest in the cultivation of biofuel feedstocks and production of liquid biofuels for export is growing with biofuel projects gradually gaining grounds in the country. Ghana has attracted the interest of several nations including Brazil, Norway, Israel, China, Germany, Netherlands, Italy and India to cultivate jatropha and other biofuel crops on large scale for biodiesel production. There are a number of community-based, small-scale biofuel projects also underway in different parts of the country. The Ministry of Local Government and Rural Development has also been implementing a Jatropha promotion programme for small farmers for a few years. A Draft bioenergy policy document is seeking to substitute national petroleum fuels consumption with biofuel by 10% by 2020 and 20% by 2030 [30].

Biogas is yet to make significant impact in the energy sector of Ghana [31,32]. The utilisation of biogas technology for cooking in residential households and small power generation has not been successful as evident in the number of abandoned biogas plants in the country [33]. High unit cost (50 US cents/kWh) of electricity generated from biogas as compared to 13–20 US cents/kWh for diesel and gasoline is an issue of concern, particularly in the context of access to modern energy services for the poor living in rural and peri-urban communities.

A recent study by Bensah [34] in which he surveyed fifty (50) biogas installations and users across the country has revealed that 58% of biogas installations in Ghana are institutional, 28% are household units, and the remaining 14% are community plants. The functional status of the 50 plants surveyed is shown in Fig. 4 which reveals the rather worrisome feature that as many as 52% of the installations are either functioning partially, not functioning or abandoned.

Reasons for non-functionality include non-availability of dung, breakdown of balloon gasholders, absence of maintenance services, lack of operational knowledge, gas leakages and bad odour in

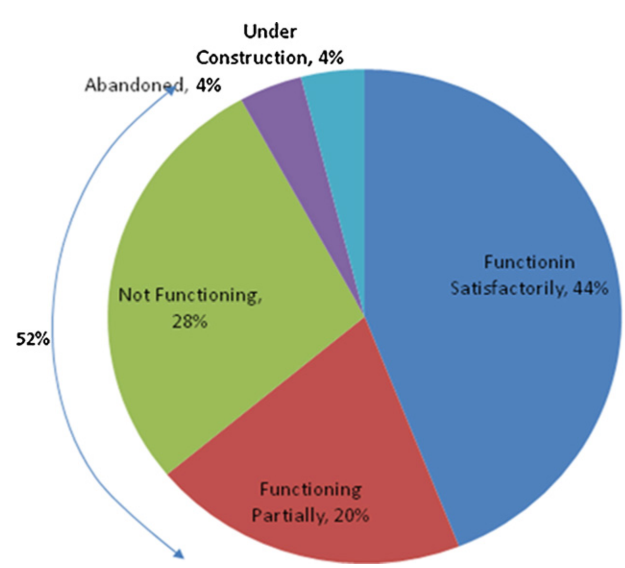


Fig. 4. Functional status of biogas plants in Ghana.
Data source: [34].

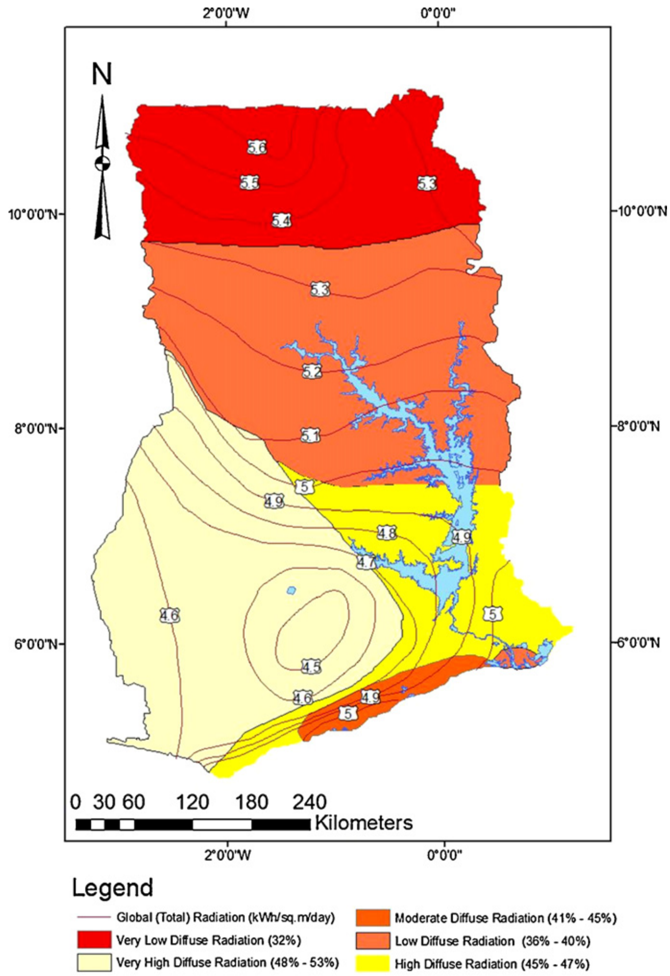


Fig. 5. Solar map of Ghana.
Source: [14].

toilet chambers of biolatrines. Bensah [34] therefore recommends the development of a national biogas programme using standardized designs to minimize the maintenance challenges, focussing on three major areas – agricultural fertilizer production, sanitation and energy – in order to improve the system economics with respect to financial as well as non-financial returns on investment.

2.3.3. *Solar energy*

By virtue of Ghana's geographical location in the tropics, solar radiation is available almost throughout the year across the ten regions [35,36]. The country receives on average 4.0–6.5 kWh/m^2/day of solar radiation and sunshine duration of about 1800–3000 h per year [14,20]. Fig. 5 shows the Solar Map of Ghana which gives a graphical presentation of the relative solar energy resource endowment across the country.

Over the years, solar PV systems have attracted considerable attention and excitement, particularly in situations of energy crisis. In Ghana, solar PV is making contributions to electricity access for household lighting, communication, water pumping and rural vaccine storage. Public solar PV electrification projects were first implemented in the early 1990s. By 1991 there were about 335 PV installations in Ghana with total estimated power of about 160 peak kilowatts [37–39]. Fig. 6 shows an increasing trend from 335 PV systems in 1991 to 4911 PV systems in the year 2003, buoyed by the implementation of the NES which began in 1990. By December 2003 about 4911 systems were installed with total installed power of 1.0 peak megawatt (MWp) [14]. Data from the Ministry of Energy

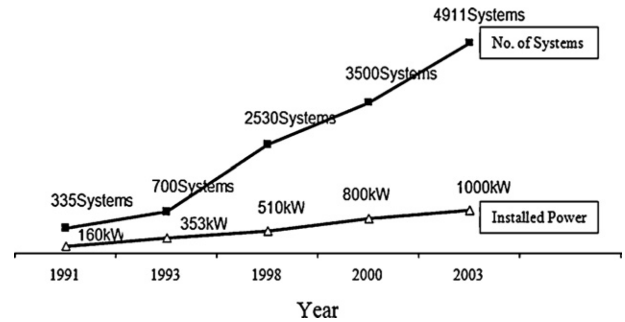


Fig. 6. Historical evolution of solar photovoltaic installations in Ghana.
Source: [39].

and other reliable sources are not available from the years 2004 to date. However, Ghana Statistical Service [8] reported 0.2% as the contribution of solar energy to the total energy supply in terms of the population using solar for lighting.

2.3.4. *Wind energy*

Over the past 20 years extensive assessment of wind energy potential in Ghana has been carried out and reliable data on wind is available for Ghana [40]. Indications are that the coastal belt of Ghana is endowed with good wind energy potential [41]. Wind measurements taken at 12 m height along the coast revealed wind speeds varying from 3.33 m/s to about 6.08 m/s. However, practically, the most economic exploitation based on current technology is at 50 m-height with annual average wind speed ranging between 7.1 and 9.0 m/s, classified as "moderate" to excellent in Fig. 7.

The lower wind speeds nearer ground level are suitable for energy conversion devices like wind-powered water pumping systems. Though some wind energy systems have been spotted in the country, there is no data on energy supply from such wind systems in Ghana and little research has been done on the potential contribution of wind energy, especially in distributed non-grid systems, towards the goal of increasing energy access for all by the year 2020.

2.3.5. *Small Hydro*

Over seventy (70) small hydro sites have been identified in Ghana but none of these has been developed so far [43]. A map showing some of the identified small and medium hydro sites in Ghana is presented in Fig. 8. It has been estimated that Ghana's small hydro potential could be put at 1.2–4 MW if the potential sites are developed as simple run-of-river projects, sized to provide power to rural communities not connected to the national grid, and at 4–14 MW if the plants are connected to the national electrical grid to absorb the excess energy output [43]. Dernedde and Ofosu-Ahenkorah [44] noticed that flows had considerably decreased in the decade leading up to their study to the extent that some of the rivers completely dry out for up to 7 months a year as a result of massive deforestation in the catchment areas of the rivers. This has resulted in considerable reductions in the technically feasible size of small hydro plants that can be developed in the country. Dernedde and Ofosu-Ahenkorah [44] recommended that, especially for the low height sites in the Volta Region, serious consideration should be given in future to the development of integrated power and irrigation infrastructure to include small hydro plant providing power to pump the water to farms and supply the excess energy to the national grid.

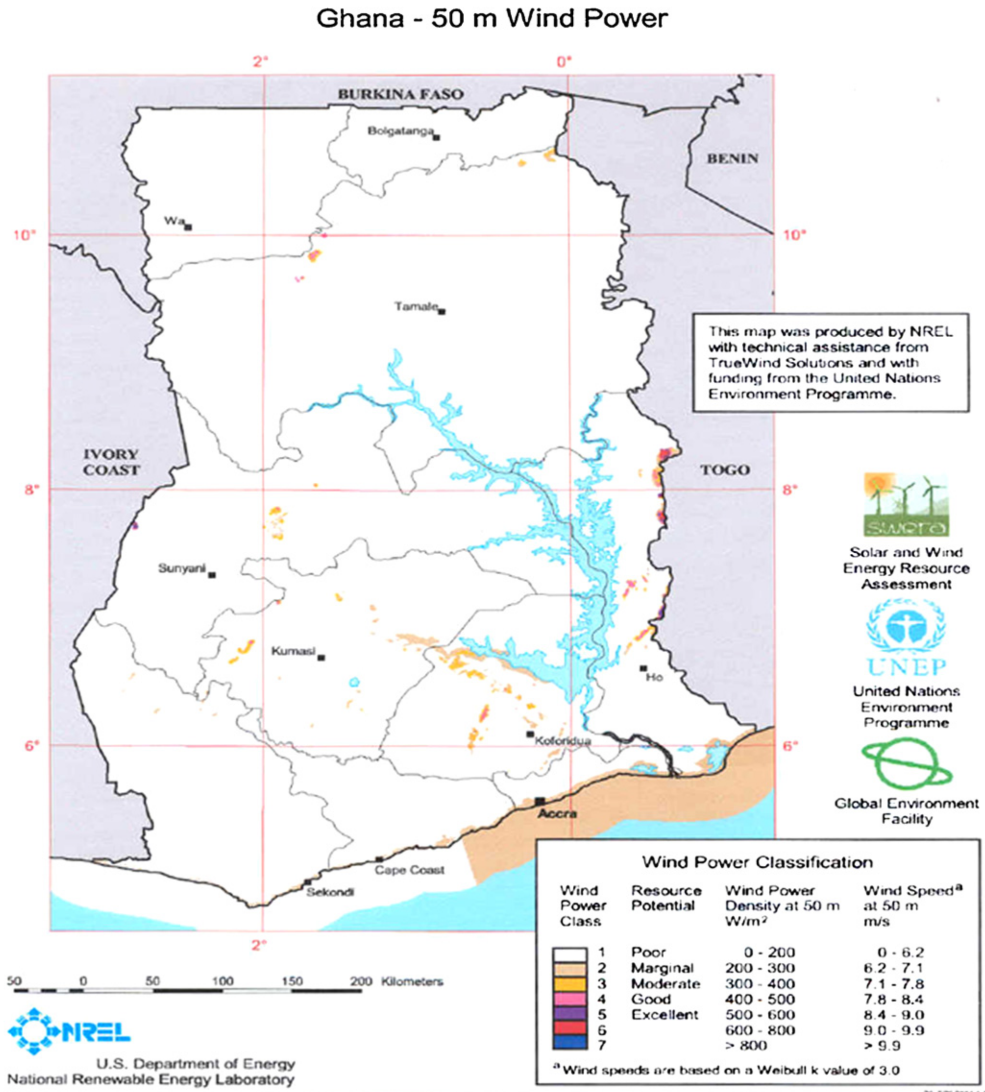


Fig. 7. Wind power map of Ghana.

Source: [42].

3. Policy framework for increasing energy access

3.1. Policies, plans and programmes up to 2000

Over the period up to the end of the 20th Century, the colonial administration of the Gold Coast and successive governments of Ghana formulated and developed various energy policies, plans and programmes to ensure the long-term reliability and security of energy supply for sustainable social and economic development of the country.

The first attempt to develop a modern legal framework for the energy industry in Ghana was in 1920, when the Electricity Supply Ordinance was passed [10]. The ordinance provided for private generation, regulation of diesel-based power and the inspection of generation activities by government officials. Under the Ordinance the Electricity Department was established as the state regulatory agency. However, due to lack of private sector participation in the industry, it became the sole power utility responsible for the generation, transmission and distribution of power. Though the idea of the Volta River Scheme originated as far back as 1915 in the colonial era, it was the first Government of Ghana that initiated the Volta River Project and saw to its completion [10].

An ambitious rural electrification programme was initiated in 1972, which had the objective of increasing electricity access for the rural population. It was pursued within what is understood from some authors as a comprehensive rural development policy [10]. The NES was introduced in 1989/1990 in which the Government of Ghana committed the country to increase electricity access to all communities with population above 500 by the year 2020 [6,27]. The NES was planned to proceed in six 5-year phases over the period 1990–2020. The electrification of the several thousand villages in the country has been assumed to be by grid extension, with community participation under the self-help electrification program (SHEP). Challenges envisaged within this programme include: low density of potential consumers of rural areas (especially in Northern Ghana); low income levels in rural communities; significant distances required for medium-voltage lines; the costs of medium and low-voltage; cost of transformers, and service drops.

In the 1990s concerns arising out of the escalating consumption of woodfuels resulted in several bioenergy programmes including the Improved Charcoal Cookstove Project, Improved Charcoal Making Project, Biogas Project, and National LPG Promotion Programme. These programmes and projects were inter alia aimed at reversing the rapid environmental and ecological damage, as

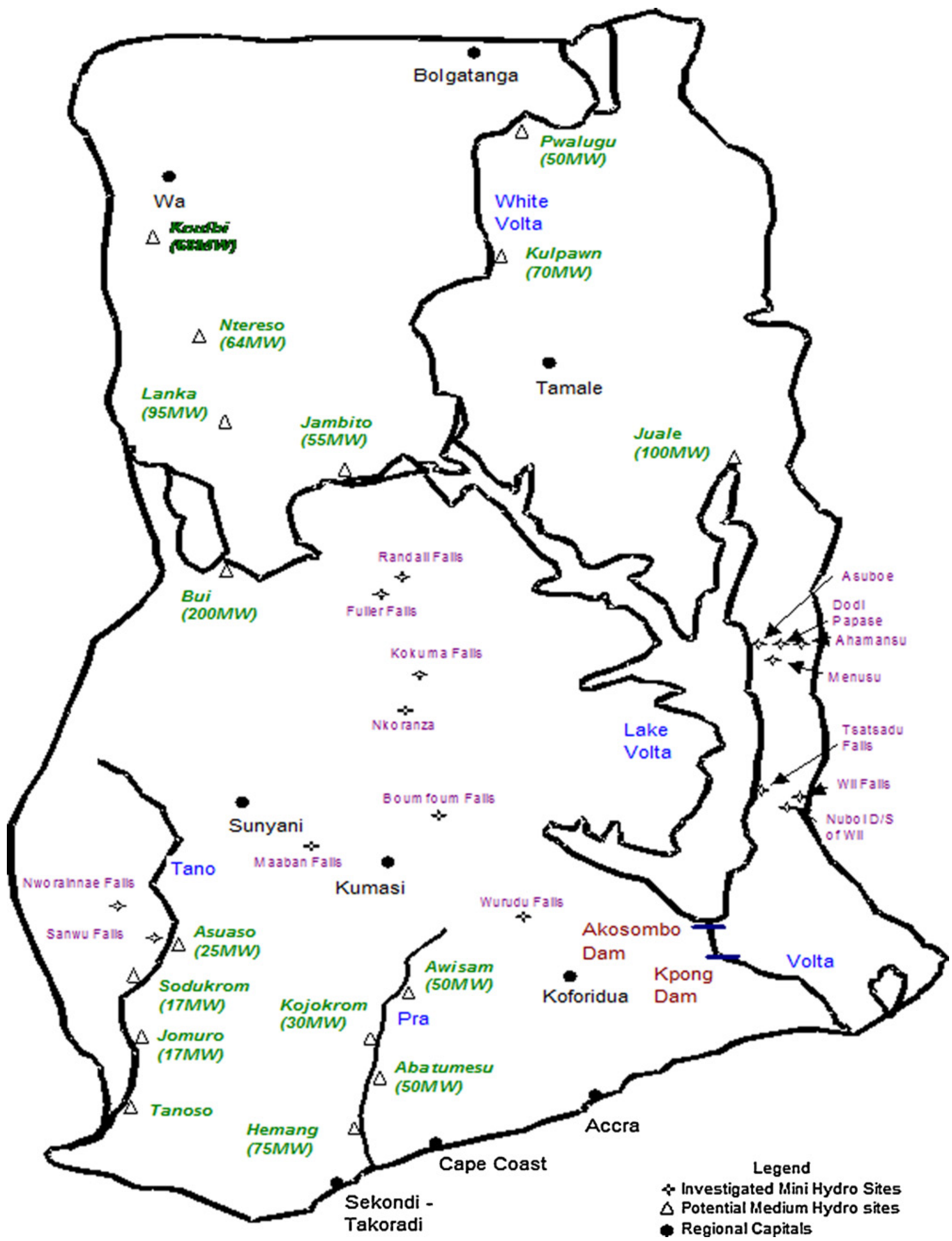


Fig. 8. Map showing small and medium hydro sites in Ghana.

Source: [43].

evidenced by perceptibly high rates of deforestation and desertification as well as the worsening effects of global warming and other atmospheric pollutants from the inefficient production and use of woodfuel [11]. The immediate objective of the national policy on woodfuel production and utilisation was to ensure sustainable production, marketing and consumption of woodfuels. A key recommendation of the policy was that government should support the promotion and development of sustainable management of the country's natural forests and woodlands for sustainable supply of wood including woodfuels [33].

3.2. Policies, plans and programmes after 2000

Between 2000 and 2005, government adopted a formal energy policy, which recognized the provision of adequate energy supply for meeting development objectives of poverty reduction and economic growth, emphasising private sector participation to overcome funding constraints. The overall Government policy was aimed at facilitating a "Golden Age of Business" and stressed on improved availability, accessibility and affordability with special focus on rural areas [16]. The Ghana poverty reduction strategy (GPRS) documentation also emphasised reliable supply of high quality energy to boost industrial development and cost recovery pricing while protecting the poor, continuation of rural electrification, promotion of energy efficiency and renewable energy. The introduction of the GPRS brought new policy directions to expand the use of renewable energy in rural electrification programmes in Ghana.

In 2006, the strategic national energy plan (SNEP) was prepared by the Energy Commission. The SNEP took a comprehensive look at the available energy resources of the country and how to tap them economically and in timely fashion to ensure a secured and adequate energy supply for sustainable economic growth up to 2020 [33]. The goal of SNEP was to contribute to the development of a

sound energy market that would provide sufficient, viable and efficient energy services for Ghana's economic development. This is to be achieved through the formulation of a comprehensive plan that would identify the optimal path for the development, utilisation and efficient management of energy resources available to the country. The SNEP identified key energy sources for long-term development and sustainability of electricity supply to include hydro-power, gas-powered thermal plant, renewables (such as wind, solar energy and biomass) and nuclear energy technologies. Unfortunately, the SNEP was not adopted formally by the Government and one of the challenges for the energy sector today is how to redress this situation and make the SNEP a binding policy document.

The Energy for Poverty Reduction Action Plan (EPRAP) is another policy document which was not formally adopted by the Government. The broad objectives of the Plan of Action proposed in EPRAP are as follows:

1. Facilitate the provision of reliable electricity to support and enhance the delivery of essential social services such as education, health care and potable water as well as the deployment of ICTs in rural areas.
2. Facilitate the provision and use of modern energy services (in the form of mechanical and/or electrical power) at the community level for all rural communities for productive applications.
3. Facilitate the provision and use of affordable modern cooking fuels and devices to at least 50% of households currently using traditional biomass for cooking.

EPRAP recommended a number of priority projects including the following:

- Grid extension to fish landing and freezing facilities.
- Establishment of woodlots and transfer of improved technology for charcoal production.
- Promotion of access to LPG in rural and poor peri urban/urban communities.
- Promotion of improved cookstoves in households.
- Windpumps for irrigation and multi-functional platforms for agro-processing.

One major programme that has taken off since 2000 is the Ghana Energy Development and Access Project (GEDAP). GEDAP is a multi-donor funded project involving the World Bank, International Development Agency (IDA), Global Environment Facility (GEF), African Development Bank (AfDB), Global Partnership on Output-based Aid (GPOBA), Africa Catalytic Growth Fund (ACGF) and the Swiss Agency for Development and Cooperation (SECO). The development objective of GEDAP is to improve the operational efficiency of the power distribution system, increase the population's access to electricity and help transition Ghana to a low-carbon economy through the reduction of greenhouse gas emissions. Electricity access expansion and renewable energy development constitutes Component C of GEDAP with a project cost of US$101.5 million. This component has three (3) sub-components: (1) the multifaceted approach, (2) grid extension and (3) isolated grids. The first sub-component is designed to support a new and multifaceted approach to expanding electricity access in Ghana tailored to geographical location, potential level of electricity demand, and distance from the existing grid, with financing for investments plus technical assistance. The second sub-component under Component C has US$50.4 million in financing costs associated with connection of un-electrified towns and villages to the national grid through the construction of 33 kV network, 11 kV and Low Voltage distribution networks, transformers, poles, connection services (drop lines, meters, etc.) and associated equipment. The third sub-component, isolated grids, has an estimated total amount of US$9.1 million to support grid-connected renewable energy such as small hydro, wind, and biomass generated electricity.

3.3. Policy mechanisms and institutions

Over the years, successive governments of Ghana have used a number of policy mechanisms to improve access to energy services for the population. Efforts have been made to restructure the power sector to provide adequate and reliable electricity as well as promote clean energy services based on energy efficient and renewable energy technologies. In the case of the power sector, growing demand for energy and constraint in supply as well as inadequate financing were the key factors that triggered reforms [43]. Relevant policy mechanisms adopted to address energy sector challenges in Ghana include regulation of electricity tariff, deregulation of petroleum pricing, setting industrial standards and permitting, education, information dissemination and stakeholder involvement [15,33,45].

To ensure the proper functioning of all players in the energy sector and to create the requisite conducive environment for the protection and enhancement of private investment in the sector, a number of regulatory agencies have been established by Acts of Parliament. These institutions are the Energy Commission, Public Utilities Regulatory Commission (PURC) and the National Petroleum Authority (NPA). The Energy Commission advises government on energy policy and strategy; and is also involved in indicative planning of energy and electricity system expansion, and licensing of energy sector operators [33]. The PURC established in 1997, is a prime body for setting tariffs and framing customer service regulations. The NPA is an independent regulator, which reviews world market price developments, the prices of imported finished products, and the operations of Ghana's Tema Oil Refinery. Even though these regulatory bodies have strived to achieve excellence in their operations, they have faced several challenges, including a lack of financial and human resources for effective monitoring [46].

The energy system in Ghana is essentially managed by the public sector. The Ministry of Energy (MOE) is responsible for formulating and implementing fuels and electricity policies. VRA generates and supply electricity to large industrial and mining units and to two electricity distribution companies—Electricity Company of Ghana (ECG) and Northern Electricity Department (NED). Under an on-going Power Sector Reform, a merger of ECG and NED to form one distribution company is being considered. The transmission function has been separated from the generation and other responsibilities of the VRA. A new company, Ghana Grid Company (GRIDCo), has been established for this function. A new Government agency, the Bui Development Authority, has also been established to oversee construction of the 400 MW hydro power plant on the Bui River. One independent power producer, Takoradi International Company (TICO), is already in operation and there are several others at various stages of project development (Osono, Cenpower and Asogli). A new rural electrification agency (REA) is proposed to be established under the current World Bank funded GEDAP [47].

Regarding petroleum products, apart from the Ghana National Petroleum Corporation (GNPC) and Tema Oil Refinery (TOR), there is the Ghana Oil Company (GOIL) and many privately owned oil marketing companies including the multinationals like Shell and TOTAL. The LPG industry has seen many private distributors and retailers. The energy sector has taken the initial steps required to show commitment to the rural population and to ensure that rural areas are not neglected. The Unified Petroleum Price Fund (UPPF) scheme initiated by the Government was meant to motivate transporters who travel to rural and distant locations, outside a radius

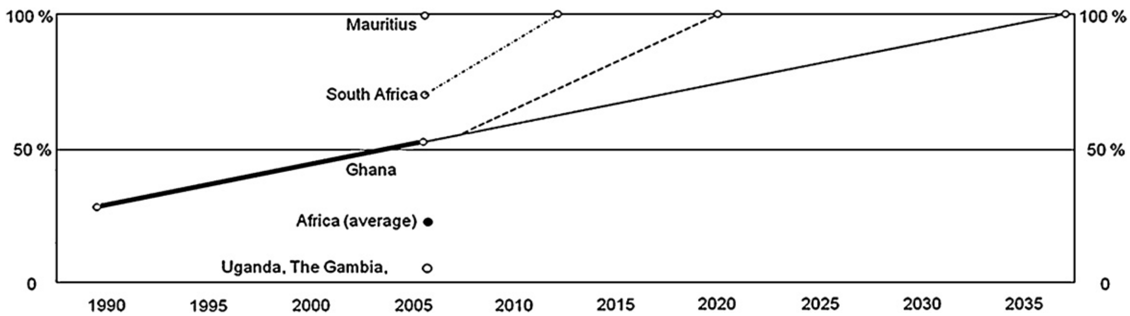


Fig. 9. Electrification status and trajectories for Ghana and selected African countries.

of 200 km from the refinery [9]. In spite of the UPPF scheme, penetration of LPG in the rural areas is still not encouraging as rural consumption is less than 2% of the national consumption [8].

The woodfuels sector represents a grey area with mostly small informal and unregulated operators. A few small and medium enterprises and some non-governmental organisations (NGOs) have been involved in the improved cookstoves market but traditional stoves are very much a thing for the informal sector. The biofuels industry is still at its incipient stages although there are promising signs of rapid growth, especially in the number of large, foreign-owned firms investing in the business of growing the feedstock and processing it for export.

The Energy Foundation is a public–private sector partnership that promotes energy efficiency and conservation in Ghana. The sector also has several active NGOs like the Kumasi Institute of Technology, Energy and Environment (KITE) and NewEnergy, involved in a range of activities from energy efficiency enterprise development to rural multi-functional platforms (MFPs).

4. Key issues and options for increasing energy access

The section is organised around three broad themes as follows:

a) Electricity for all by 2020;
b) LPG/improved cooking systems for all by 2015;
c) More productive uses of rural/renewable energy.

4.1. *Electricity for all by 2020*

Ghana currently ranks third highest in sub-Saharan Africa, after Mauritius and South Africa, as far as access to electricity is concerned. Mauritius has already achieved universal electrification and South Africa is aiming to do the same by 2012 (see Fig. 9). Current rates of electrification in Ghana may not lead to full electrification by 2020, as set by originally in the NES and reaffirmed by the current Government. Fig. 9 shows that a major shift in the current electrification trajectory to something similar to South Africa's, will be required if Ghana is to meet the 2020 target.

Alternative Energy Africa [48] estimates Ghana's rate of increase in demand for electricity at 10–15% per annum over the last two decades. Thus an important consideration is to match the growth rate of electricity demand with adequate supply at reasonable prices. Though progress has been made towards achieving the goal of securing reliable and adequate supply of electricity at reasonable prices, much effort is needed to improve existing installed capacity, manage generation and distribution losses as well as reduce costs and prices to reasonable levels. This raises major questions on both the supply and demand sides of the electricity supply chain.

On the supply side, the growing demand for energy and the constraints in supply as well as inadequate financing were the key factors that triggered reforms in the energy sector. In the case of the power sector, the on-going reform/restructuring programme has proceeded in fits and bursts over the last 15 years. If the sector is to succeed in playing its role towards meeting the 2020 universal access target, a renewed impetus will be required in the implementation of the reform/restructuring programme and more dynamism will be needed in the distribution as well as generation sides of the industry. The generation side of the industry could also benefit from the introduction of more dynamism to ensure that adequate electricity supply is guaranteed.

The ambition of Ghana's founding fathers to produce cheap electricity has not been sustained due to several challenges including the lack of a combination of coherent policies among others to consolidate, improve and diversify sources of electricity supply in Ghana [33]. Contrary to this ambition, electricity prices have been rising and several mechanisms, including regional power pooling, are being put in place to reduce electricity costs and improve reliability. Reforming the power sector and driving more dynamism into the industry with a good eye on the ECOWAS regional electricity market could well be the approach that might deliver the much sought-for local benefits as far as affordable access is concerned.

4.2. *LPG/improved cooking systems for all by 2015*

As discussed in previous sections of this review, about 9% of Ghana's population in 2005 used LPG as their main energy source for cooking. The corresponding LPG access rates for rural areas, urban areas and Accra are 2%, 17% and 30%, respectively. With Ghana's urban population predicted to approach 60% by 2030 it should be possible to take advantage of the relative ease of LPG uptake in urban areas and double LPG access from the 2005 rate of 9% to something much closer to 20%, with the rest of population using improved woodfuel-based cooking services, by 2015.

Abavana and Mahama [49] have proposed a strategy focused on "promoting the growth of a commercial market for clean energy services, with an active role for government as a regulator and civil society as a facilitator". They called for "more emphasis on engaging the local authorities (municipalities) and the private sector more effectively, and using the public–private partnership (PPP) business model for service delivery". Togobo [50] has pointed out that, based on previous studies, there is a strong correlation between the level of household income and the type of fuel used, with low income households preferring traditional fuels like charcoal, firewood and agricultural residues and higher income households relying on more conventional fuels like LPG and electricity. He points out further that between kerosene and LPG, the fuel of choice is the latter. Government may therefore choose to continue providing support within its kerosene pricing policies/distribution set-up to ease the price changes resulting from transportation, while expanding and intensifying policy measures for the promotion of use of LPG by those who can afford this throughout the country. As indicated above, a doubling of LPG access to about 20% by 2015 would still

Table 3
Distribution of cattle population in the three most cattle-rich regions of Ghana.

Region	Cattle population	No. of cattle owning households	No. of cattle owning agric. households	Average cattle per agric. household
Northern	982,847	98,090	85,142	11.5
Upper West	787,681	28,250	23,645	33.3
Upper East	454,112	47,577	39,441	11.5
Total	2,224,640	173,917	148,228	15.0

Source: [34].

leave some 80% to be served with other forms of improved cooking services.

4.3. More productive uses of rural/renewable energy

It has been argued elsewhere that efforts which succeed in integrating productive uses and income generation activities into energy access initiatives, whether based on conventional fuels or renewable energy, may well turn out to be the deciding factor if the dream of energy for all in sub-Saharan Africa is to become a reality in the foreseeable future [3]. In line with this argument, Fig. 10 drives home the importance of coupling energy access initiatives with productive uses of energy, essentially in industry and agriculture. It demonstrates how a close coupling between energy access initiatives and productive uses of energy may be important in and of itself, as well as important for the main socio-economic sectors addressed in the MDGs, namely, Social wellbeing (including gender), Health, Education and Environment (SHEE). A recent study in Northern Ghana concluded that the low contribution of energy towards rural development is to a large extent driven by an energy policy that inhibits the delivery and use of modern energy sources in rural Ghana [51]. Achieving an energy future that has greater relevance to rural development will therefore require a mix of policy tools that enhances the delivery and use of modern energy systems in rural communities in the country.

The extent to which Ghana is able to successfully pioneer energy access initiatives with embedded linkages to productive uses/income generation may therefore help to make the difference, whether or not universal access to modern energy services will be achieved by 2020. The challenge of incorporating strong productive use elements in energy access initiatives in general and renewable energy schemes in particular cannot be underestimated. But there is evidence to suggest that with some careful thinking and innovative programme design, this should be feasible with tangible results for all to see. For instance, an important feature of the woodfuels consumption pattern in Ghana is the use of agricultural residues in the poorer regions of the country. As shown in Fig. 11 for the Upper East region, the population depending on agricultural residues for cooking is as high as 30% pointing to the scarcity of wood in many parts of the region and the endemic poverty levels that put even charcoal or other commercial fuels out of reach.

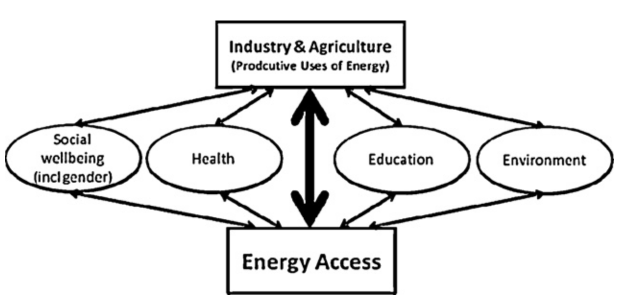


Fig. 10. A framework for co-benefits from energy access and productive uses of energy.
Source: [3].

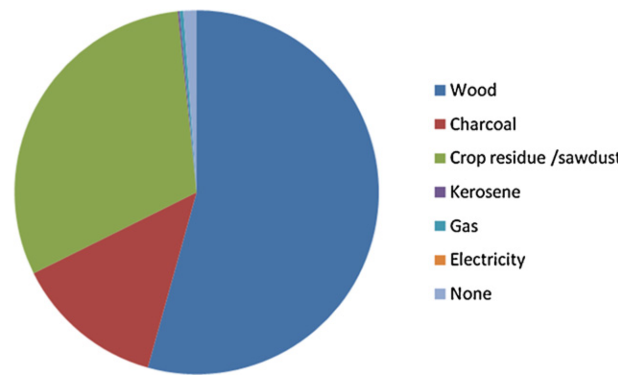


Fig. 11. Types of cooking fuels used in the upper east region of Ghana.
Data source: [8].

Interestingly enough, the Upper East and Northern regions have the same number of cattle per agricultural household, second only to that in the Upper West region (Table 3). The potential for household level biogas plants designed to produce fertilizer to improve agricultural yields, in addition to energy for cooking and lighting, is therefore considerable. It is unclear why to date, why such a programme has not seen the light of day. The numbers suggest that this could open the door for not only increasing access to modern energy services but also generating the incomes necessary for improving their social welfare of poor rural families.

5. Conclusions and recommendations

5.1. Conclusions

Biomass in the form of woodfuel, remain the most prominent fuel in Ghana for cooking and heating. Firewood and charcoal contribute about 63% to the total energy consumed in the country and is a major source of worry considering the effects on deforestation and the health problems associated with indoor pollution from the use of biomass. Even though some strides have been made in LPG consumption in urban areas, especially in the Ashanti and Greater Accra Regions, access to LPG is still lower than expected and even worse in the rural areas. Renewable energy has not made much contribution to the energy mix in Ghana. Gains in solar PV have been modest when compared to the country's potential. Wind energy and small hydro resources have not been exploited fully and biofuel programmes are still in the feedstock stage with little to show in terms of the production of commercial fuels. There has been a remarkable growth in electricity supply from the late 1980s buoyed by the NES and later SHEP (under the NES). This has raised electricity access rate from 28% in 1988, through 43.7% in 2000 to about 55% in 2008, a feat only rivalled by South Africa in sub-Saharan Africa, but with disparity in rural and urban areas.

Ghana faces several challenges which frustrate efforts to achieve national energy access targets and goals. These challenges include growing demand for energy but with inadequate investment to match the demand, high levels of end-use inefficiency culminating

in waste of final energy forms and inefficient pricing of energy services resulting in poor financial positions of the energy providers. Other challenges are operational inefficiencies of the utilities leading to high energy losses, under-exploitation of renewable energy sources and over reliance on woodfuels which could threaten the country's forest cover.

There have been several plans, policies and programmes aimed at increasing access to energy in Ghana over the last few decades. Governments over the years have had the provision of energy services high on the developmental agenda but despite the good intentions of all these governments to increase access to energy services, existing policies and plans have not delivered effective results, especially in the rural areas. The country's electrification policy which aims at making available cheap electricity for all could not be sustained due to several challenges including the lack of a combination of coherent policies among the different stakeholders to consolidate, improve and diversify sources of electricity supply in Ghana. Several policy mechanisms and institutions have come on board over the years, all in the aim of delivering a better energy access to Ghanaians. While VRA and GRIDCo deal with the generation and transmission, respectively, of electricity, ECG and NED have been responsible for distribution. Efforts at policy formulation and regulation have been handled by the Energy commission and the PURC.

5.2. *Recommendations*

The main recommendations arising out of this review may be summarized as follows:

1. There is the need for a coherent national energy policy with inputs from a wider section of the public that has precise targets and clearly laid down strategies to achieve the targets. Such strategies should involve funding mechanisms.
2. Efforts should be made towards achieving 100% access to electricity and 20% access to LPG by 2020 and 2015, respectively.
3. Efforts at promoting and making available renewable energy technologies at cost-effective prices should be stepped up. Perhaps this calls for the passage of the renewable energy law which hopefully should establish incentives for the renewable energy industry.
4. Energy access initiatives should be coupled with productive uses of energy, especially in rural areas, and enterprise-centred approaches should also be promoted vigorously.
5. Government should support academic and research institutions in the country to build capacity for more R&D into energy technology and policy so that they can complement government efforts at achieving 'sustainable' energy for all in Ghana in the near term.

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